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CASE REPORT

# Arthrofibrosis of the Knee After Tibial Spine Fracture in Children: A Report of Two Complicated Cases

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## Introduction

Tibial spine fracture is an uncommon injury in children and adolescents [1]. According to Meyer's classification [2], nondisplaced or minimally displaced type I and type II fractures can be treated by external splint or long leg cast in extension [1–4]. Displaced type III or type IV (displaced and comminuted) fractures often require closed or open reduction with either arthrotomy or arthroscopic-assisted methods using sutures or hardware [1, 3, 5–7]. In literature, the reported complications of tibial spine fractures include anterior knee instability, extension loss, quadriceps weakness, and chondromalacia [3, 8]. Although arthroscopic treatment has the advantages of early mobilization and reduced hospital stay, there have been reports of suboptimal clinical results, which include loss of knee extension or instability [6, 8].

This is a report of two children with type III tibial spine fracture treated by open reduction in one and arthroscopic reduction in another. Postoperatively, both had arthrofibrosis that led to extension contracture in one child and flexion contracture in another. Both children had subsequent fracture of the distal femur during rehabilitation/manipulation of the knee contracture, directly related to the arthrofibrotic change. We recommend informing parents and children about arthrofibrosis and its sequelae in preoperative discussion for fixation of tibial spine fracture. Also, every effort should be made to prevent this significant complication by appropriate treatment of tibial spine fracture and attentive physical therapy.

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## Case reports

### Case 1

A previously healthy 13-year-old boy was involved in a motor vehicle accident, sustaining a closed head injury and a right type III tibial spine avulsion fracture. The tibial spine fracture was treated with open reduction and suture fixation through the proximal tibial epiphysis. The knee was placed in an extension long leg cast postoperatively. Three weeks post surgery, he had superficial wound breakdown, which was treated with local wound care and oral antibiotics for 10 days. Later, the wound continued to discharge intermittently. The cast was removed 7 weeks postoperatively and physical therapy was initiated.

He had significant postoperative knee stiffness, and 14 weeks postoperatively, he suffered a nondisplaced right supracondylar femur fracture during physical therapy. At this point, his treating surgeon performed formal irrigation and debridement of discharging wound over the knee. The femoral fracture was immobilized in an extension cast for 3 months, during which time the patient received a 6-week course of intravenous antibiotics for wound cultures positive for *Staphylococcus aureus*. The wound healed uneventfully.

The patient initially presented to the authors' institution 1 year post injury with a right knee range of motion from 0° to 10° of flexion. Radiographs revealed evidence of a healed supracondylar femur fracture (Fig. 1). After an initial trial of physical therapy, surgical management was


**Fig. 1.** **a** Anteroposterior and **b** lateral radiograph of the right knee at presentation

offered for his severe knee extension contracture. A modified Thompson quadricepsplasty [9] was performed. The vastus medialis obliqus (VMO) and vastus lateralis were released from the rectus femoris, the vastus intermedius was released from the overlying rectus femoris and from the underlying femur, and a lateral parapatellar release was performed through the anterior incision. Additionally, posteromedial and posterolateral capsulotomies were performed through separate incisions. Intraarticular adhesions were released in the suprapatellar pouch and in the intercondylar

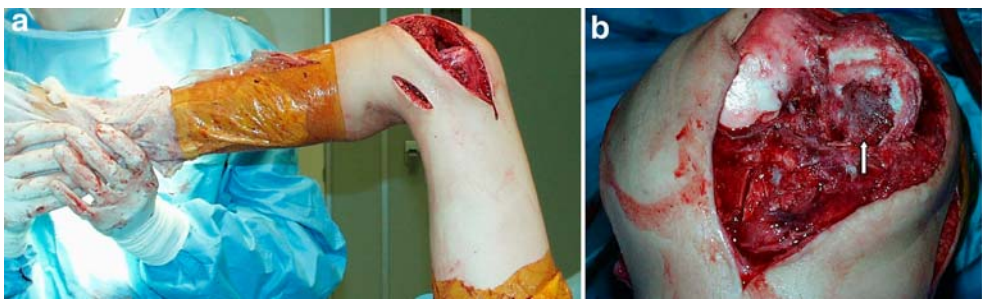


**Fig. 2.** Intraoperative pictures. **a** Incisions for quadricepsplasty and knee flexion up to 110°. **b** Delaminated cartilage (*arrow*) over the medial femoral condyle

notch. Intraoperatively, 110° of knee flexion was obtained after the release (Fig. 2a). The medial femoral condyle was found to have a large area of delaminated cartilage, measuring 2×4 cm (Fig. 2b). The medial meniscus was absent. The muscles were reapproximated with the knee at 45° of flexion and the wounds were closed.

Postoperatively, the patient was managed with intravenous patient-controlled analgesia and continuous CPM. He continued to use CPM at home for 4 weeks postoperatively. Now, 4 years post surgery, his active knee range of motion is from 0° to 110° (Fig. 3a and b). He actively participates in bicycle riding, surfing, and skateboarding. He experiences only occasional medial knee discomfort, and he is not taking any pain medication. His radiographs and magnetic resonance imaging (MRI) of the knee demonstrate severe medial compartment degenerative changes.

## Case 2

A 10-year-old girl was diagnosed with right knee type III tibial spine avulsion injury after a ski accident. She was initially treated in another institution with arthroscopic repair of the avulsed tibial spine using suture fixation. Postoperatively, a long leg cast was applied for 5 weeks. After the removal of the cast, she had significant knee stiffness. She underwent physical therapy for 6 weeks and her knee range of motion was 20° to 45° of flexion. Because of continued stiffness, closed manipulation under general anesthesia was performed. After the manipulation, she had significant thigh swelling and warmth. She was placed in CPM for rehabilitation. Continued pain and swelling of the distal thigh, 3 weeks post manipulation, prompted a radiograph of her knee. The X-ray revealed a minimally displaced healing fracture of her distal femoral physis. She was further immobilized in a long leg cast for 4 weeks.

The patient initially presented to the authors' institution 10 months post injury. She was ambulatory with a single crutch. She had active knee range of motion from 60° to 80° of flexion. AP and lateral radiographs of the right knee demonstrated a 45° flexion deformity of the distal femur at the site of the distal femoral physeal fracture (Fig. 4a). MRI of the distal femur confirmed both the flexion deformity and the presence of two discrete physeal bony bars (Fig. 4b).

Staged surgery was offered in the form of initial correction of bony deformity to be followed by lysis of intraarticular adhesions. Distal femoral extension osteotomy with blade plate fixation was performed to correct both the bony deformity and complete the distal femur epiphysiodesis. The surgery was tolerated well, and postoperatively, she was placed in a long leg cast with the knee in extension for 4 weeks. After cast removal, she had physical therapy to improve her knee range of motion. Four months postoperatively, she had a range of motion from 0° to 25° of flexion (Fig. 5a and b). Scanogram


**Fig. 3.** Clinical picture. **a** Full extension of knee. **b** Flexion of 110°


**Fig. 4.** **a** Lateral radiograph of the right knee at presentation. **b** Coronal and sagittal MRI showing bony bar (*arrow*)

revealed a 1.1-cm leg-length discrepancy (LLD), left longer than right. The projected LLD was 3.6 cm.

The planned second surgery was performed 4.5 months postoperatively and consisted of: (1) arthroscopic lysis of the adhesions of the right knee and (2) left distal femoral screw epiphysiodesis. Arthroscopic findings in the right knee revealed extensive fibrous tissue filling the intercondylar notch, suprapatellar pouch and fibrous bands running from patellar tendon to fat pad and femoral trochlea. Extensive lysis of the adhesions achieved a range of motion from 0° to 130° of flexion. Postoperatively, she had CPM followed by outpatient physical therapy. At the final follow-up (30 months post injury and 18 months post arthroscopic release), she had passive knee range of motion from 10° to 145° of flexion. Actively, her knee flexion ranged from 10° to 140°. She had a 0.6-cm leg-length discrepancy, left longer than right.

## Discussion

Both cases illustrate severe arthrofibrosis of the knee after operative fixation of type III tibial spine fracture, in part secondary to prolonged immobilization for treatment of iatrogenic distal femoral fracture. Infection was an additional contributory cause in the first case.

Joint immobilization alone may produce extraarticular changes including disorganization of ligament cellular and fibrillar alignment, weakening of ligament insertion sites, regional osteoporosis, increased force requirements for joint cycling, and increased ligament compliance [10]. Intraarticular changes include proliferation of fibrofatty connective tissue filling the joint space, adhesions between synovial folds, adherence of fibrofatty connective tissue to cartilage surfaces, atrophy of cartilage, and cartilage ulceration [10]. Biochemical changes in the periarticular soft tissues occur relatively early and contribute to gross changes in joint kinematics [10–12]. Immobilization of the knee joint is well known to produce detrimental cartilage changes in animal models [10, 11, 13]. Also, in human cadaveric arthrofibrotic knees, similar intraarticular changes are noted [14].

In our first case, medial meniscus was absent. This meniscal pathology may be directly related to the trauma (tibial spine avulsion), prolonged immobilization, infection, and/or arthrofibrosis. Because of these confounding etiologic factors, the medial joint changes may not be completely attributable to arthrofibrosis. However, it appears that arthrofibrosis had a partial role in causation of medial joint changes. In our second case, the distal femoral fracture had united in 45° of flexion. The knee had a 60° flexion deformity with further range of motion to 80°. Thus, arthrofibrosis contributed for 15° of flexion deformity of the knee and further restriction of range of motion.

Normal knee range of motion requires congruent articular surfaces, adequate muscle function, an articular capsule with suitable capacity and flexibility, effective space in the medial and lateral articular recesses, intercondylar notch and suprapatellar pouch, and sufficient meniscal motion [11]. Knee range of motion may be compromised by intraarticular or extraarticular trauma, prolonged immobilization, surgery, or infection.

Arthrofibrosis describes the condition of restricted joint motion characterized by a dense proliferation of both intraarticular and/or extraarticular scar [11] noted in both of our cases. Extension contracture of the knee is far less common than flexion contracture. Surgical approaches for extension contracture include arthroscopic release and/or quadricepsplasty [9, 15–18]. Flexion contracture can be treated with serial long leg casts with increasing knee extension, open or arthroscopic surgical release with hamstring lengthening, and/or external fixation devices [19]. It is important to note that posterior capsular pathology may play a role in limiting flexion and extension, and may need to be addressed in both flexion and extension contractures [11, 16, 17].

Recovery of motion does not necessarily produce a satisfactory clinical outcome. Despite improving flexion to 97% of the opposite extremity and decreasing extension deficits from 14° to 3°, only 23 of 37 patients (62%) achieved satisfactory functional results in 1 study [16]. In addition, follow-up radiographs at an average of 3.6 years demonstrated that 89% of knees showed degenerative changes, 51% showed soft tissue calcifications, and 9%

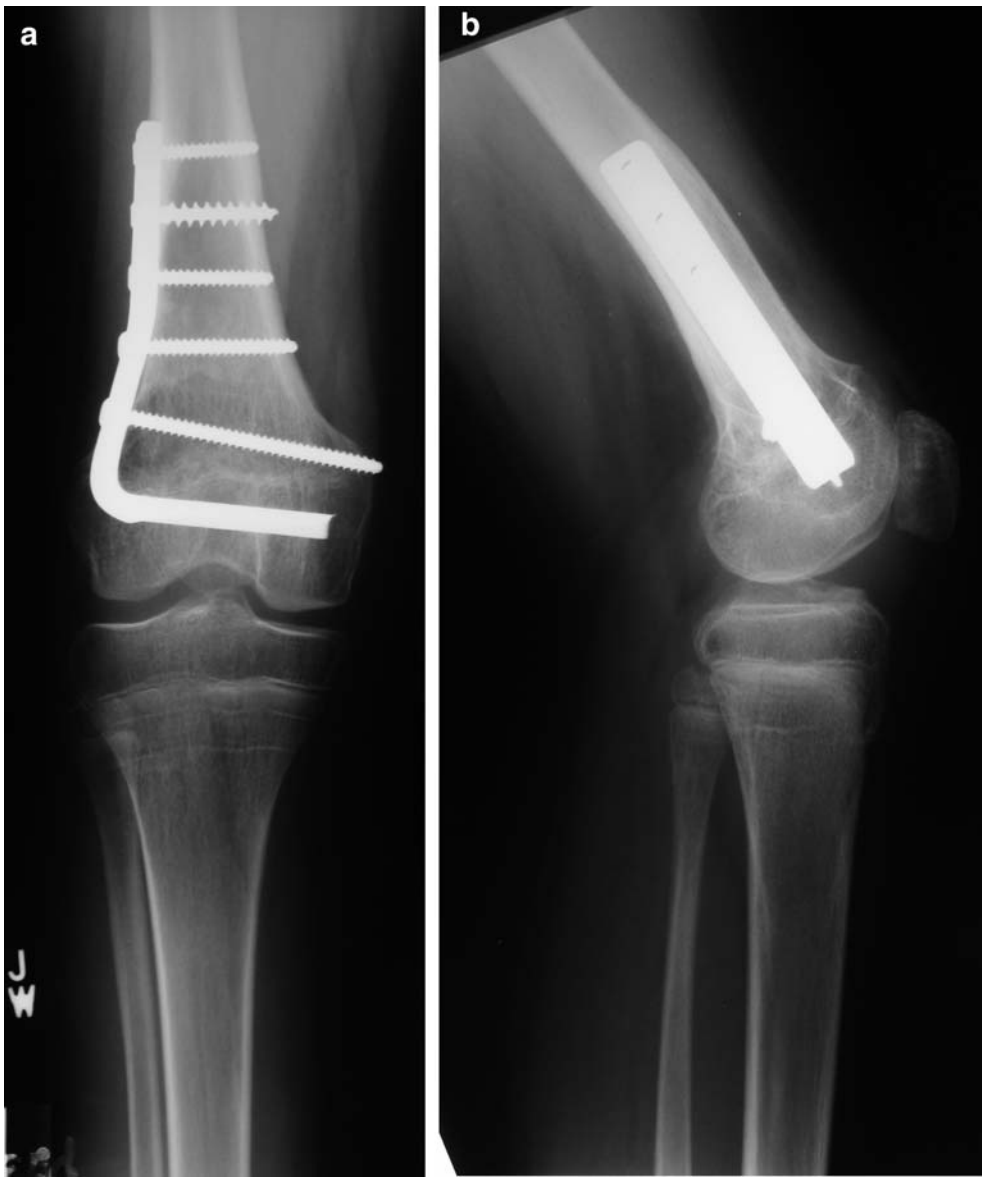


**Fig. 5.** **a** Anteroposterior and **b** lateral radiograph of the right knee 4 months post surgery

showed patella infera [16]. Patellofemoral arthrosis is common in severe cases of arthrofibrosis, as infrapatellar contracture increases patellofemoral contact pressures.

Both cases represent severe examples of knee arthrofibrosis and its sequelae after tibial spine fracture. Arthrofibrosis may have multiple etiologies that include initial trauma, prolonged immobilization, infection or secondary fracture. It is well established that arthrofibrosis and adhesions of anterior structures limit flexion, but our first case illustrates that an excessively tight posterior capsule may also limit flexion. Although we were able to achieve good range of motion, both patients experienced a prolonged course to recovery with the first patient developing significant degenerative changes in the knee. As recovery of motion does not necessarily produce a satisfactory clinical outcome, every effort should be made to prevent this significant complication by appropriate treatment of tibial spine fracture and attentive physical therapy.

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